Transmitted by Email to LCFSworkshop@arb.ca.gov

March 17, 2017

Transportation Fuels Branch
Industrial Strategies Division
California Air Resources Board

Re: Comments in relation to the Workshop on Co-processing of Biogenic Feedstocks in Refineries, Feb 07, 2017

INTRODUCTION

Iogen Corporation ("Iogen") would like to thank California's Air Resource Board (ARB) for the opportunity to comment on the Feb 07, 2017 workshop on co-processing of biogenic feedstocks in refineries.

Iogen is one of the world's leading firms in the field of cellulosic biofuels. We have been in the cellulosic biofuel business for over 30 years, invested roughly $500 million in research, development and demonstration and have more than 300 issued and pending patents. We have implemented our cellulosic ethanol production technology in Brazil at Raizen Energia's 10 million gallon per year Costa Pinto Facility, which is now producing cellulosic ethanol from bagasse. We are also very active in the deployment of biogas-based cellulosic biofuels in the United States. We are currently distributing about 17 million gallons per year (ethanol equivalent) of biogas-based cellulosic biofuel to Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) locations in the United States, and are planning more than 100 million gallons per year of biogas-based production in the next three years.

We are excited about the potential for cellulosic biofuels in America and specifically California. There is an abundance of feedstock, an abundance of fuel demand, and current laws that recognize the unique value and potential of cellulosic biofuels. In particular, we believe there is tremendous short term potential for the use of biogas-derived renewable hydrogen by California refiners to make "renewable hydrogen content" (RHC) in California fuels. Under the current Renewable Hydrogen Refinery Credit Pilot Program (RHRCPP), the generation and refinery use of renewable hydrogen is eligible for the generation of LCFS credits. We applaud California's forward thinking approach in adopting these regulations.

We estimate that the potential GHG reduction to be achieved using biogas for refinery incorporation of renewable hydrogen in fuels is about 4.5 million tonnes of CO_2 per year. This reduction would be a direct result of avoiding the extraction and use of fossil natural gas that ends up as refinery-produced transportation fuel used in California.

US EPA approval of RHC in gasoline and diesel for RIN generation under the federal Renewable Fuel Standard (RFS) will unlock this new and economical means for GHG reduction in the California fuel pool. Until such time, we believe the commercial adoption of biogas use

under the RHRCP Program will remain limited. The economic incentive or RINs that can be generated outside California far exceeds the value of LCFS credits that can be generated within California (RIN value is more than 5X the LCFS credit value in CNG). Currently, EPA has not made approval of a pathway for RIN generation with RHC a priority. We believe the support of California-based refiners and CARB could help accelerate adoption. We welcome CARB's support in this respect.

We are making comments herein in association with the co-processing workshop because refinery hydrogen use seems to have been bundled with the general use of biomass-based feedstock in refineries. As described below, we believe that the two approaches are completely different; each governed under separate sections of the regulations, and should be considered as separate non-overlapping matters.

We have divided our comments into the following two groups:

1) Comments on the application of the current regulations
2) Recommendation for improved regulations

BASIS FOR LCFS CREDIT GENERATION USING REFINER RENEWABLE HYDROGEN

In 2015, the California ARB approved the re-adoption of the Low Carbon Fuel Standard (LCFS), which included a Renewable Hydrogen Refinery Credit Pilot Program. This program enabled a refinery to receive LCFS credits from the production of gasoline or diesel that is partially derived from renewable hydrogen.

As per the regulation, the calculation of credits is as follows:

$$Credits_{RIC}^{H} = \left((CI_{Fossil}^{H} - CI_{Renewable}^{H}) \times D_{Renewable}^{H} \times V_{Renewable}^{H} \times C\right)$$

where:

$Credits_{RIC}^{H}$ is the amount of LCFS credits generated (a zero or positive value), in metric tons, by renewable hydrogen;

CI_{Fossil}^{H} is carbon intensity requirement of fossil hydrogen in gCO_2e/MJ from Table 6 for Hydrogen with the pathway identifier HYGN003;

$CI_{Renewable}^{H}$ is the carbon intensity of the renewable hydrogen in gCO_2e/MJ, as determined by section 95488(c)(4)(F);

$D_{Renewable}^{H}$ is the energy density of hydrogen listed in Table 3 in MJ/kg;

$V_{Renewable}^{H}$ is the volume of renewable hydrogen in kg; and

$C = 1.0 \times 10^{-6} \frac{MT}{gCO_2e}$.

The baseline fossil pathway HYGN003 is for hydrogen produced from natural gas at a centralized location via steam methane reformation (SMR), pipelined to a hydrogen refueling station and compressed to 10,000 psi. Argonne developed the energy efficiency values and fuels shares for the SMR process. The CI of HYGN003 is 105.65 mg/MJ. Included in this amount is 10.32 mg/MJ for compression and transport of the hydrogen.

COMMENTS ON APPLICATION OF THE CURRENT REGULATIONS

1) **We believe refinery renewable hydrogen should remain separately regulated from refinery processing of biogenic feedstocks.**

   - The eligibility for credit generation under the Renewable Hydrogen Refinery Credit Pilot Program is under a different section of the LCFS regulations than the sections that would apply for fuels made from biogenic feedstocks using co-processing. Credit generation, as specified in the regulations (i.e. a different baseline), is based on a different formula. There are additional provisions limiting the generation and transfer of credits generated using renewable hydrogen, such limitations not applying to refiner processing of biogenic feedstocks.

- The production of renewable hydrogen from renewable natural gas (i.e. biomethane transferred by pipeline displacement) is a pure displacement with no change in chemical reactions, no change in facility capacity, no change in products produced, and no change in byproducts. Refinery processing of biogenic feedstocks changes the chemistry and products, and is not a direct displacement.

- Refineries already incorporate hydrogen in finished fuel (via hydrogenation reactions), and renewable hydrogen displaces fossil-based hydrogen content in finished fuels. The use of renewable hydrogen is a simple displacement that can be accounted by a simple substitution of fossil-based hydrogen. The displacement method is consistent with conventions of GHG lifecycle evaluations for such a situation. However, refinery co-processing feedstocks would use an appropriately different methodology, as this is not a simple displacement.

- The Renewable Hydrogen Refinery Credit Pilot Program regulations are consistent with a displacement method approach to volume quantification. The regulations do not require a tracking of the quantity of renewable hydrogen incorporated in finished fuel, rather there is an assumption that all hydrogen produced is eligible for credit generation. The baseline for credit generation is fossil-derived hydrogen, not the gasoline/diesel baseline, also consistent with a displacement. It is worth noting that any EPA RIN generation would require tracking of renewable hydrogen disposition into fuel, so the $V^{H}_{Renewable}$ in the credit generation formula is likely to be in line or aligned with the actual hydrogen incorporated in fuel.

- Tracking thru carbon dating does not work for renewable hydrogen. We believe the most appropriate method for quantifying the quantity of renewable hydrogen produced is to use the energy fraction of feedstock that is renewable biomethane, and to designate the same fraction of hydrogen as renewable. We would expect EPA to use this same method in respect of RIN generation under EPA's co-processing rule.

2) We believe the $CI^{H}_{Renewable}$ should include the CA-GREET burdens of refinery incorporation of hydrogen and fuel transport and distribution base upon energy content.

- Given the baseline for the generation of credits is HYGN003 (a finished fuel including the burdens of processing and transport for use as a vehicle fuel), we believe the appropriate basis for the assessment of $CI^{H}_{Renewable}$ should include similar "hydrogen conversion to fuel use" burdens.

- We believe CA-GREET includes the necessary information to make this allocation, and that the CA-GREET numbers should be used (as opposed to refinery specific data).

- Our preliminary assessment is that the burden for hydrogen in gasoline is 10.74, and hydrogen in diesel is 11.92. These numbers include both hydrogen incorporation and transportation to refueling stations. Given 79% of the fuel pool is gasoline, and the balance diesel, we believe the basis for the $CI^{H}_{Renewable}$ assessment should be the weighted average of the two numbers, 10.99 g CO2/MJ. We believe that regardless of it destination, this number should be used for all hydrogen.

- For renewable hydrogen as fuel under HYGN003, we calculate that the post-SMR burdens for processing and transport are renewable hydrogen are 10.32 mg/MJ. For the incorporation of renewable hydrogen into conventional fuels, we calculate the CA_GREET burdens should be 10.99 g CO2/MJ. This we believe this approach offers an appropriate "apples to apples" comparison.

RECOMMENDATION FOR IMPROVED REGUALTIONS

1) We believe CARB should change the baseline CI^{H}_{Fossil} from HYGN003 to the CA-GREET CI value for each refinery's hydrogen

- Under the current regulations, with the hydrogen baseline as HYGN003, the number of LCFS credits generated will relate to the performance of each hydrogen plant. This means that, for a given amount of fossil hydrogen substituted, efficient plants will generate more credits than inefficient plants. We believe this is misaligned with the actual GHG savings achieved, and thus it is misaligned with the general intent of the LCFS.

- We believe more closely aligning the LCFS credit generation with the achieved GHG benefits will lead to additional viable sites, increased adoption, and ultimately lower cost GHG emissions reductions for consumers.

- The actual GHG saving that occurs with the substitution of renewable hydrogen for fossil hydrogen is driven solely by the substitution of fossil natural gas feedstock by biomethane feedstock. If the fossil hydrogen baseline was changed from HYGN003 to the CA-GREET value calculated for each refinery's hydrogen production (i.e. using the GREET hydrogen production model with each

refinery's specific inputs and outputs), then the number of LCFS credits generated would more accurately estimate the actual GHG reductions.

- In order to accomplish this change, we would recommend the following modifications to the credit generation formula:
  - Same formula:

$$Credits_{RIC}^{H} = \left((CI_{Fossil}^{H} - CI_{Renewable}^{H}) \times \ D_{Renewable}^{H} \ \times \ V_{Renewable}^{H} \ X \ C \right)$$

  - With the following modified definitions:

CI_{Fossil}^{H} is the carbon intensity of fossil hydrogen in gCO_2/MJ as determined by section 95488(c)(4)(F), using the CA-GREET hydrogen production model, natural gas as a feedstock, and refinery-specific hydrogen production inputs and outputs.

$CI_{Renewable}^{H}$ is the carbon intensity of renewable hydrogen in gCO_2/MJ as determined by section 95488(c)(4)(F), using the CA-GREET hydrogen production model, the specific source of biomethane as a feedstock, and refinery-specific hydrogen production inputs and outputs.

2) We believe CARB should ultimately not limit the generation or trading of LCFS credits generated from refinery renewable hydrogen use

- Given the goal of the LCFS is to have a technology-neutral platform for decarbonizing the California fuel pool; we believe limiting the adoption of individual solutions (such as fuels that contain renewable hydrogen) is not consistent with this goal.
- We believe there is a certain amount of overhead associated with the adoption of refinery use of renewable hydrogen, and there should not be a restriction on one refiner's ability to transfer LCFS credit to another refinery. The transferability of LCFS credits is a feature that contributes to market efficiency that is in the interest of California consumers.
- We recognize CARB's interest in proving the viability of the refinery renewable hydrogen pathway before opening up broad adoption. We look forward to working with CARB to address concerns with this pathway.

CONCLUSION

Refinery incorporation of renewable hydrogen in fossil fuels is a large opportunity for reduction of GHG emissions from California transportation fuels. The current regulations are workable, and we look forward to cooperating and discussing with CARB on implementation.

As identified herein, we believe that the regulations can be further developed, clarified and improved.

Should CARB have any questions, require any information, or be interested in assistance in understanding our analyses or positions, we welcome further discussion and review.

Sincerely,

Patrick J. Foody
Executive Vice President and Chief Operating Officer
Iogen Biogas Corporation